# A WebGIS tool for the dissemination of earthquake data

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## 1. INTRODUCTION

In 2004 a new seismic hazard map of Italy (MPS Working Group, 2004) has been released by a task force that produced an amount of new or updated data, such as a new version of the earthquake catalogue (CPTI04; CPTI Working Group, 2004) and an updated seismogenic zonation. A set of WebGIS tools has been designed for the data dissemination to the scientific community and the general public.
The design of the WebGIS tools focused first on the consultation of the **DBM04 macroseismic database** (DBM Working Group, 2005), which contains the macroseismic intensity data-points (IDP) of the earthquakes listed in the CPTI04 catalogue.
The WebGIS tool design and development process had to fulfill: 1) **simplicity**, 2) **responsiveness** and 3) readiness for **future extensions**.
The specific requirements for the macroseismic database consultation interface were:
- data access by place and by earthquake;
- IDP maps with queryable points;
- data download in both tabular and map format;
- easily upgradable content;
- quick and user friendly interface.

## 2. EARTHQUAKE DATA

The macroseismic intensity datapoints in DBM04 (fig.1) are 58'926 related to 1024 earthquakes out of 2550 listed in the CPTI04 catalogue, for which an intensity distribution has been assessed. An **intensity datapoint (IDP)** is identified by (fig.2): the place name, its geographical coordinates, and the macroseismic intensity assessed according to a macroseismic intensity scale.

| Field | Parameter definition | Data type | |
|---|---|---|---|
| NCPT04 | Earthquake ID in CPTI04 | numeric | integer |
| AN | Year | numeric | integer |
| ME | Month | numeric | integer |
| GI | Day | numeric | integer |
| OR | Hour | numeric | integer |
| MI | Minute | numeric | integer |
| SE | Second | numeric | integer |
| AE | Epicentral area | text | 27 |
| RT04 | Root | text | 6 |
| NP | Number of macroseismic observation | numeric | integer |
| I0 | Epicentral intensity | text | 5 |
| LAT_EP | Epicentre latitude | numeric | 6.3 |
| LON_EP | Epicentre longitude | numeric | 6.3 |
| MAW | Moment magnitude | numeric | 1.2 |
| ZS9 | Seismogenic zone | numeric | 3 |
| NDBM | Record ID | numeric | integer |
| NLOC | Place ID | numeric | integer |
| TOP | Place name | text | 49 |
| SC | Special case | text | 2 |
| LAT | Latitude | numeric | 6.3 |
| LON | Longitude | numeric | 6.3 |
| IS | Site intensity | text | 5 |
| COU | Country code | text | 2 |
| PROV | Province code (only italian places) | text | 2 |
| COM | Municipality name (only italian places) | text | 35 |
| ISTAT | Municipality code (only italian places) | text | 8 |

Fig.1 - Database structure.

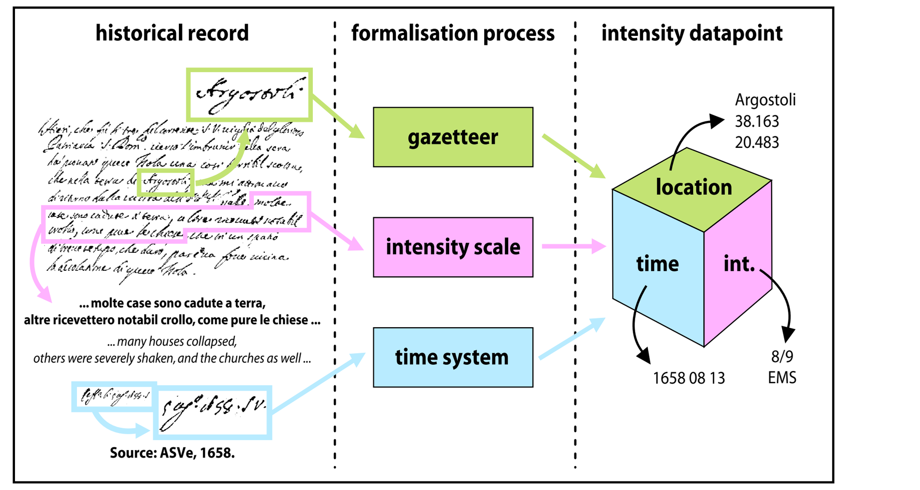


Fig.2 - Intensity datapoint identification process (Stucchi et al., 2000).

The 58'926 intensity datapoints in the database are supplied by **different studies that used different formats** with regards to: name standards, coordinates rounding, etc. Thus implementing a **homogeneous database** required:
1) referring the macroseismic observations to places listed in a unique and standard reference directory;
2) correcting possible mistakes in the georeferencing of the IDP, deriving mostly from the original association of an observation coming from the primary source to a place with the same name but different geographical location.
This process was sped up by the WebGIS tool that, through the map rendering, permitted a **rapid check and validation** of each of the 58'926 input IDP locations. With this procedure over 1'000 IDP locations were corrected, and some examples are shown in figure 3.
The **continuous feedback from potential users** helped finding bugs and implementing new features. The system was tested both locally and remotely, being the working group distributed in different places in Italy.

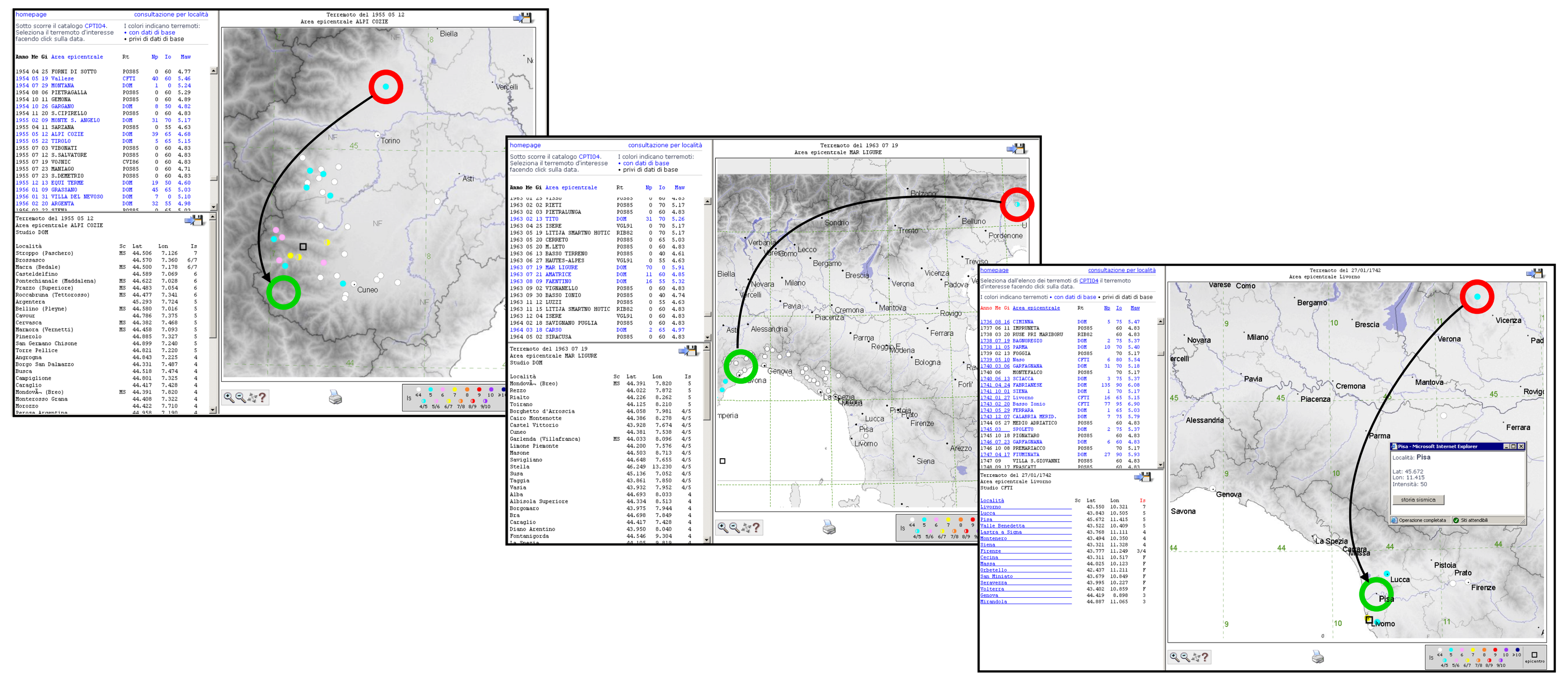

Fig.3 -Examples of check and correction of wrong IDP localizations.

## 3. DESIGN PHASE

We tested, among others, the following WebGIS tools but **none of them was completely suitable** for our purposes:
- ESRI ArcIMS: its customization is difficult because of the complex technology and requires a very powerful configuration webserver;
- DBx GeoMatics SVGMapMaker: matched some of the goals, but it is designed for a simple representation of maps;
- TimeMAP by the University of Sydney: its java technology is too limited compared to its complexity and is poorely documented.

Thus **we designed our own system** according to the the design process in figure 4 and choosing the following technologies for implementing it:
- **MySQL database management system:** widely adopted, clear documentation, good balance of speed and features, open standard, free;
- **PHP programming language**: widely adopted, huge quantity of examples, direct access to MySQL, complete set of features for the web environment, open standard, free;
- **SVG scalable vector graphic**: supports script-driven interactivity, good documentation, being a vector format can offer a perfect image quality, open standard, free.

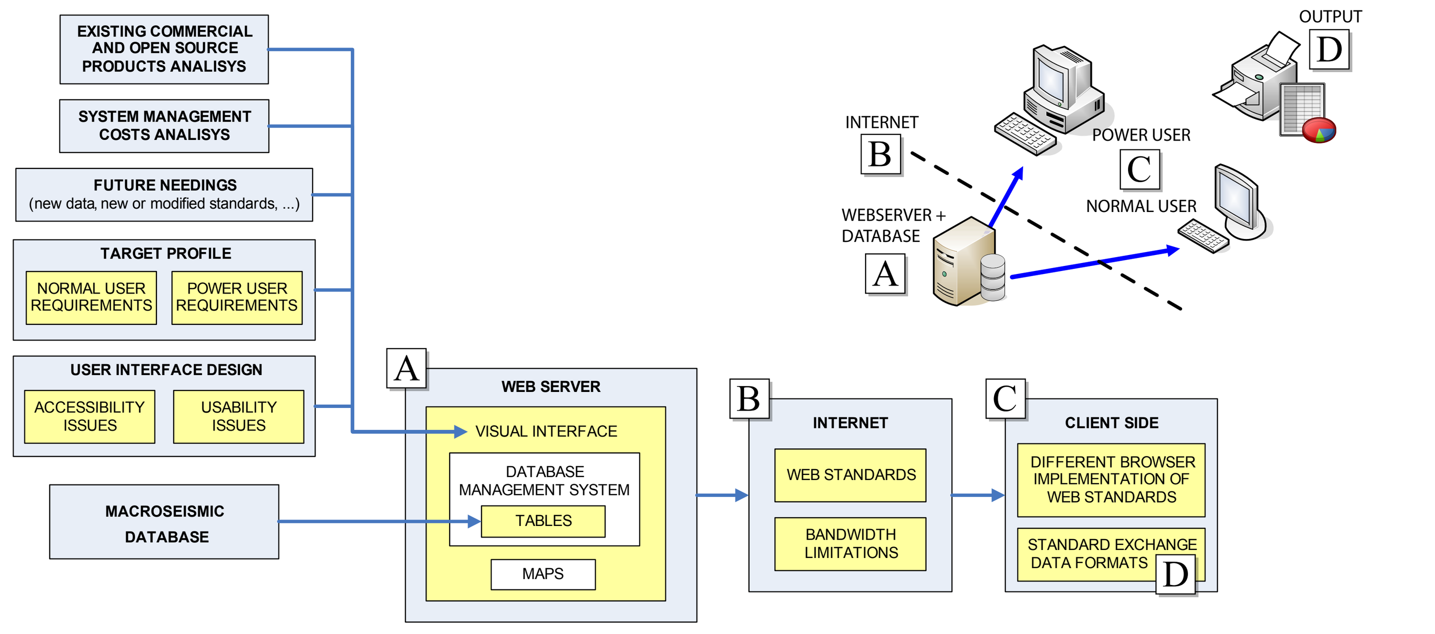


Fig.4 - Design process of the WebGIS tool.

### The Scalable Vector Graphic (SVG) format

SVG is a platform for two-dimensional graphics. It has two parts: an XML-based file format and a programming API for graphical applications. Key features include shapes, text and embedded raster graphics, with many different painting styles. It supports scripting through languages such as ECMAScript and has comprehensive support for animation.
SVG is used in many business areas including Web graphics, animation, user interfaces, graphics interchange, print and hardcopy output, mobile applications and high-quality design.
SVG is a royalty-free vendor-neutral open standard developed under the W3C Process. It has strong industry support; Authors of the SVG specification include Adobe, Agfa, Apple, Canon, Corel, Ericsson, HP, IBM, Kodak, Macromedia, Microsoft, Nokia, Sharp and Sun Microsystems. SVG viewers are deployed to over 100 million desktops, and there is a broad range of support in many authoring tools.
SVG builds upon many other successful standards such as XML (SVG graphics are text-based and thus easy to create), JPEG and PNG for image formats, DOM for scripting and interactivity, SMIL for animation and CSS for styling.

*Source: W3C. SVG Overview, http://www.w3.org/Graphics/SVG/About*

## 4. TECHNICAL DETAILS

SVG technology requires the installation of the **free Adobe SVG Viewer plug-in**.
Being the lightweight footprint one of the main goals on both the server-side and the client-side (fig.5) we decided to cache every data automatically generated by the system: this process decreases dramatically the computing power needed on the webserver.
Developing the interface we realised that too much time elapsed between the earthquake selection and the browser displaying the map, and four main factors delayed the visualization:
1) map generation on the server, solved with a **cached pre-generation of maps**;
2) map file transferring time, solved with a **GZ compression** of the SVG file and **cropping the raster image of the DEM** (Digital Elevation Model) to the selected earthquake intensity distribution area;
3) client hardware configuration: **the SVG file is completely managed by the client** computer, its CPU and its RAM must be up-to-date. We guarantee a satisfying use of the system starting from a CPU clocked at least at 1Ghz and a system equipped with a minimum RAM size of 384Mb;
4) client software configuration: the SVG plug-in supports quite well MS Explorer v.6+ on Windows; other browsers have problems with the Javascript communication between html pages and SVG objects. **Our system investigates the client browser configuration** and consequently enable or disable SVG features as the place find function on maps.
Beta version browsers include the SVG technology, which will finally end the Adobe plug-in dependency.

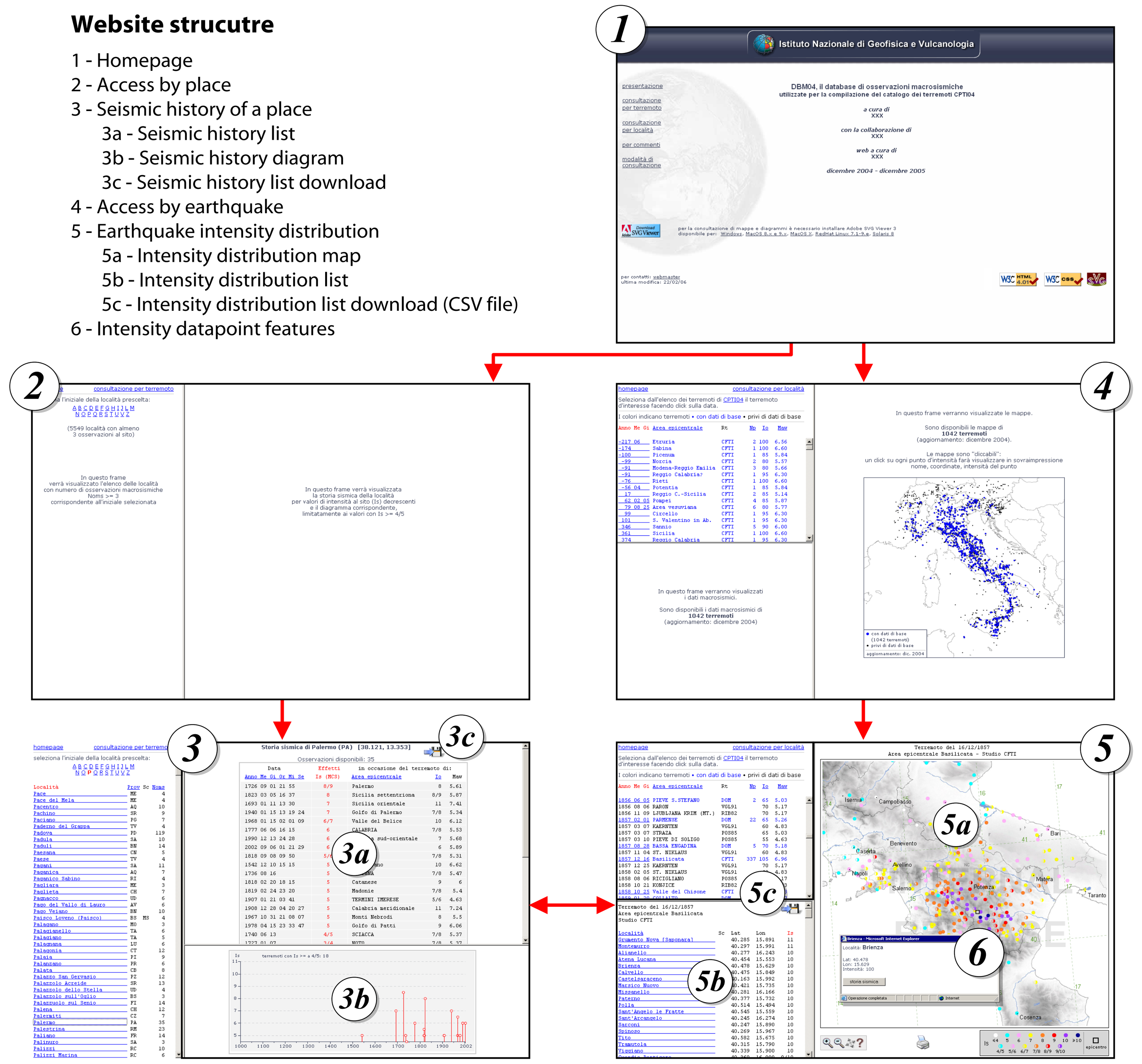


Fig.5 - Website screenshots showing the consultation structure.

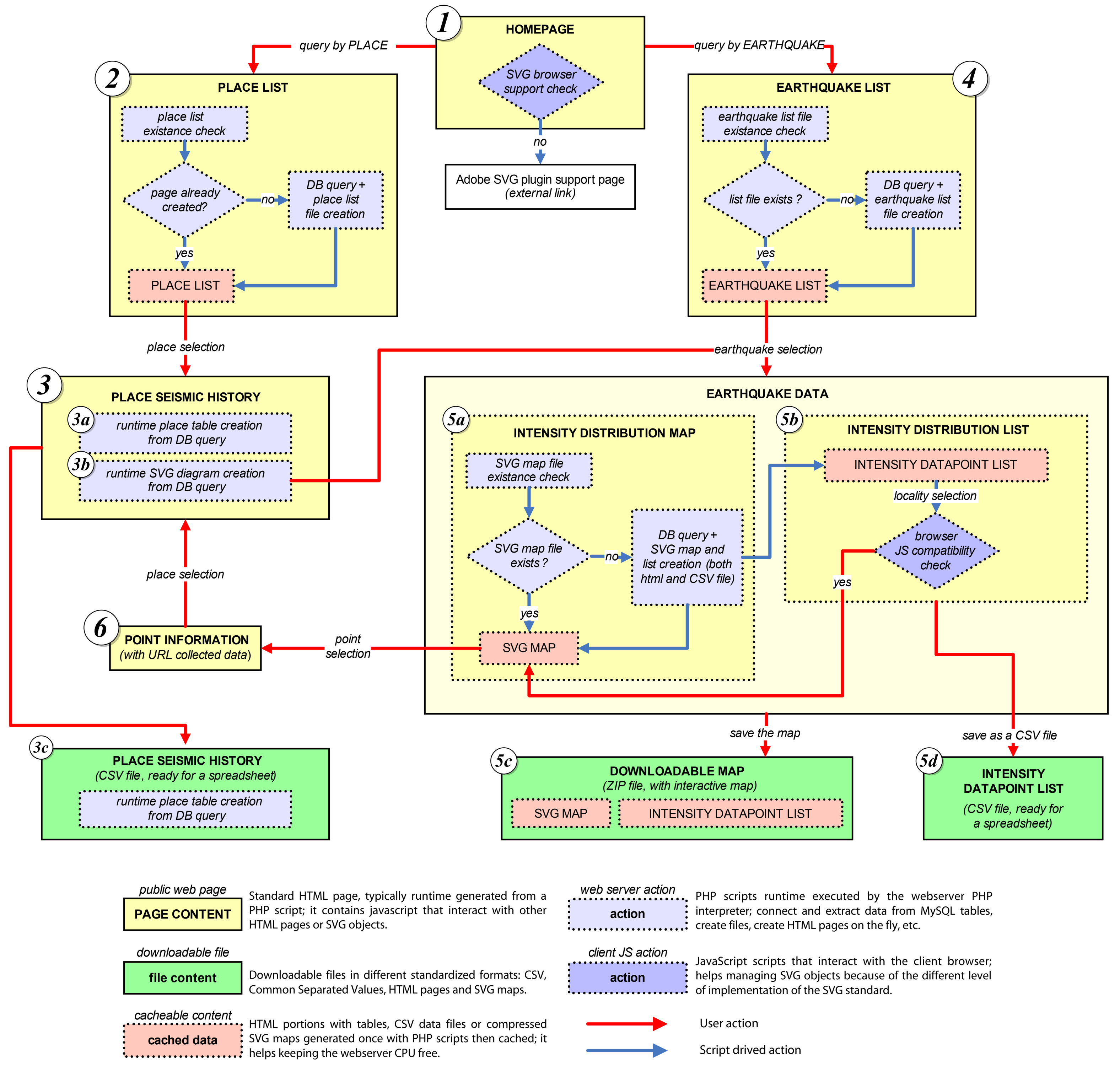


Fig.6 - Internal workflow schema of the WebGIS tool.

## 5. CONCLUSION AND FUTURE DEVELOPMENT

As the computation procedures of the new seismic hazard map of Italy had to be **reproducible and its input data accessible**, the dissemination of earthquake data, i.e. the CPTI04 catalogue and its related macroseismic database DBM04, was one of the main tasks.
After the analysis of existing software solutions, we designed an ad-hoc tool adopting a technology that allowed to reach a good balance between accessibility, speed, functionalities and compatibility. The resulting product **does match the initial goals** and allows every kind of user to access the available data on the damage pattern of historical and recent earthquakes. Another advantage of the adopted SVG technology is its independency from the server, which make possible to obtain off-line interactive maps. The only disadvantage is a not complete control on how the client side works with the SVG technology.
Although the macroseismic database consultation interface is not yet published, it has been widely tested within the working group during the validation and homogenization process of the database. The feedback has been very positive and useful for tuning and implementing the WebGIS tool.
Since our main goal is the **dissemination of data on both historical seismicity and seismic hazard** of Italy a specifically designed website will be created.
At the moment, **a new module for the visualization of seismic hazard maps** assessed for different return periods is in a feature design stage.
Given the large amount of data to manage, we focused on the feature definition and developed an environment temporarily based on ESRI ArcIMS (fig.7-8).
We found this software the quickest one to experiment new ways of disseminate this kind of data, before the final technological implementation.

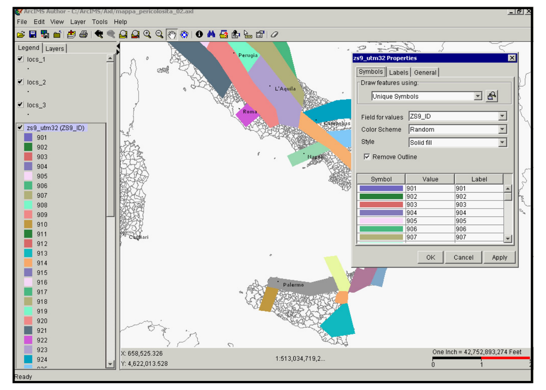

Fig.7 - Test of the seismic hazard map module.

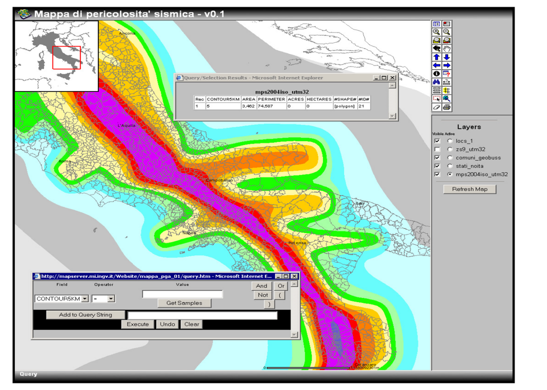

Fig.8 - Test of the seismic hazard map module.

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